Introduction

Chapter Background

Science & Engineering Indicators 2000 showed that advances in information technology (IT) (i.e., computers and communications products and services) drove an increase in technology development and allowed the United States to increase technical exchanges with its trading partners.[1] This edition of *Science and Engineering Indicators* examines many of the same indicators, with additional perspectives provided by international data on service industries and on patenting activity in two new areas, human DNA sequencing and Internet business methods. New data on applications for U.S. patents by residence of inventor have also been added.[2]

Chapter Organization

This chapter begins with a review of industries that rely heavily on research and development (R&D), referred to here as “high-technology industries.”[3] High-technology industries are noted for their high R&D spending and performance, which produce innovations that can be applied to other economic sectors. These industries also help train new scientists, engineers, and other technical personnel (see Nadiri 1993; Tyson 1992). Thus, the market competitiveness of a nation’s technological advances, as embodied in new products and processes associated with high-technology industries, can serve as an indicator of the economic and technical effectiveness of that country’s science and technology (S&T) enterprise.

The global competitiveness of the U.S. high-technology industry is assessed through an examination of domestic and worldwide market share trends. Data on royalties and fees generated from U.S. imports and exports of technological know-how are used to gauge U.S. competitiveness when technological know-how is sold or rented as intangible (intellectual) property. Also presented are new leading indicators designed to identify those developing and transitioning countries with the potential to become more important exporters of high-technology products over the next 15 years.

This chapter explores several other leading indicators of technology development by examining changing emphases in industrial R&D among the major industrialized countries and comparing U.S. patenting patterns with those of other nations in two important technology areas, human DNA sequencing and Internet business models.

The chapter also examines venture capital disbursements in the United States by stage of financing and by technology area. Venture capital is used in the formation and expansion of small high-technology companies.

U.S. Technology in the Marketplace

Most countries acknowledge a symbiotic relationship between investment in S&T and success in the marketplace: S&T support competitiveness in international trade, and commercial success in the global marketplace provides the resources needed to support new S&T. Consequently, the nation’s economic health is a performance measure for the national investment in R&D and in science and engineering (S&E).

The Organisation for Economic Co-operation and Development (OECD) currently identifies four industries as *high-technology* (science-based industries whose products involve above-average levels of R&D): aerospace, computers and office machinery, communications equipment, and pharmaceuticals.[4]

High-technology industries are important to nations for several reasons:

- High-technology firms innovate, and firms that innovate tend to gain market share, create new product markets, and/or use resources more productively (National Research Council, Hamburg Institute for Economic Research, and Kiel Institute for World Economics 1996; Tassey 1995).
- High-technology firms develop high value-added products and are successful in foreign markets, which results in greater compensation for their employees (Tyson 1992).
- Industrial R&D performed by high-technology industries benefits other commercial sectors by generating new products and processes that increase productivity, expand business, and create high-wage jobs (Nadiri 1993; Tyson 1992; Mansfield 1991).

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[1]This chapter presents data from various public and private sources. Consequently, country coverage will vary by data source. Trend data for the advanced industrialized countries are discussed in all sections of the chapter. When available, more limited data for fast-growing and smaller economies are added to the discussion.

[2]Trends in the number and origin of U.S. patent applications provide a more current, albeit less exact, indication of inventive patterns than that provided by the chapter’s examination of U.S. patents granted.

[3]No single preferred methodology exists for identifying high-technology industries, but most calculations rely on a comparison of R&D intensities. R&D intensity, in turn, is typically determined by comparing industry R&D expenditures or the numbers of technical people employed (e.g., scientists, engineers, technicians) with industry value added or the total value of its shipments. In this chapter, high-technology industries are identified using R&D intensities calculated by the Organisation for Economic Co-operation and Development.

[4]In designating these high-technology industries, OECD took into account both direct and indirect R&D intensities for 10 countries: the United States, Japan, Germany, France, the United Kingdom, Canada, Italy, the Netherlands, Denmark, and Australia. Direct intensities were calculated by the ratio of R&D expenditure to output (production) in 22 industrial sectors. Each sector was given a weight according to its share in the total output of the 10 countries using purchasing power parities as exchange rates. Indirect intensity calculations were made using technical coefficients of industries on the basis of input-output matrices. OECD then assumed that, for a given type of input and for all groups of products, the proportions of R&D expenditure embodied in value added remained constant. The input-output coefficients were then multiplied by the direct R&D intensities. For further details concerning the methodology used, see OECD (1993).